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tions to reach it, and who, therefore, was completely possessed of his intellectual vigor, which is always diminished after bodily toil. He makes no account of the nervous strain of the ascent, or of the anticipation of the far more dangerous descent, and this strain would be a more severe tax on the faculties of most persons than even violent and continued exertions. Those who remember M. JANSSEN's cool ride *on horseback* over the crater-floor of *Kīlauea*, in 1883,\* can understand that the danger of Mt. Blanc might seem a little thing to him, but it is difficult to think that his plan for a physical observatory among those perils is a practical one. It is permissible to admire his courage and devotion, and yet, in the name of Science, to suggest that the dangerous summit of Mt. Blanc be abandoned for such a purpose, and that the proposed observatory be established on Pike's Peak, only a few hundreds of feet lower, at the end of a railway and telegraph line already in operation, and in a situation where it is perfectly practicable to maintain observers during the entire year, with few difficulties and with no peril; or, if not at Pike's Peak, then at some station less dangerous than Mt. Blanc. Of M. JANSSEN's expedition and of his project we may be permitted to say, with the fullest admiration for his courage and for his successes, but with a recollection of the limitations of ordinary men—

“C'est magnifique, mais ce n'est pas la guerre.”

E. S. H.

ARGELANDER'S DURCHMUSTERUNG MAPS WANTED.

The Lick Observatory is in want of the maps (only) of ARGELANDER's *Durchmusterung* (first section,  $+90^{\circ}$  to  $-2^{\circ}$ ), and will be glad to know of a set for sale.

E. S. H.

ON THE RING-SHAPED MOUNTAINS OF THE MOON † [BY DR. H. EBERT, OF THE UNIVERSITY OF ERLANGEN].

Dr. EBERT, whose studies have been directed to the question of the mode of formation of the ring-shaped craters on the Moon, has done a very useful work in his last paper on the subject, by discussing all the data afforded by the labors of SCHMIDT, BEER and MÆDLER, WARREN DE LA RUE and others.

The object of the research is to determine if there are any char-

\* Very likely this particular escapade of the venerable astronomer is unknown in Europe, though it is well remembered in Hawaii, and serves as a companion-piece to his escape from Paris in a balloon, during the Franco-Prussian war, in order that he might go to India to observe the Eclipse of 1871.

† Ueber die Ringgebirge des Mondes; *Sitzungsberichte d. Physik-Med. Societaet Erlangen* (1890).

acteristic relations between the various dimensions of the ring-craters, as their diameters, the height of the outer walls above the general surface, the height of these walls above the interior of the craters, the height of the peaks in the interior of the rings, etc., etc. The relation between the cubic contents of the outer walls and that of the interior of the crater is also specially examined.

The materials for the discussion are drawn, as has been said, from works already published. These materials are first put into a tabular form for convenience. For each ring-crater, there is given the average interior depth ( $J$ ); the height of the outer wall above the exterior surface of the Moon ( $A$ ); the diameter of the crater ( $D$ ); the height of the central peak ( $h$ ); the inclination of the outer wall towards the interior ( $a$ ) and towards the exterior ( $B$ ) in degrees. These and other data are given for 92 ring-craters—all that could be utilized in this discussion. It should be remembered that some of the data are quite uncertain.

The author next proceeds to form the various ratios, etc., expressed by

$$\frac{J}{A}, \quad J-A, \quad \frac{J}{D}, \quad \frac{D}{h}, \quad \frac{J}{h},$$

$$d = J-A-h, \quad \frac{D}{d}, \quad \frac{J-d}{D}, \quad J-d, \quad \frac{J}{p}, \quad K,$$

and  $E = 1 - K$  where  $K$  is the ratio of the cubic contents of the outer walls to that of the interior of the crater.

The author's results are briefly as follows:

1st: The ratio  $\frac{D}{J}$  varies between 7 and 70; that is, the ring-craters are from 7 to 70 times as broad as they are deep. We must not regard such formations as "deep depressions," etc., but rather as dish-like cavities. In fact there are many ring-craters so broad that a spectator stationed on one wall could not see the opposite one, because it would be hidden from him by the convexity of the Moon's surface.

2d: The smaller ring-craters are relatively the deepest. This is clearly shown in the following little table ( $J$  is the depth,  $D$  the diameter in kilometers):

Small craters; $D =$ about	28 kilometers; $J = \frac{1}{10} D$ ;
Average craters; $D =$ about	60 kilometers; $J = \frac{1}{20} D$ ;
Large craters; $D =$ about	105 kilometers; $J = \frac{1}{32} D$ ;
Largest craters; $D =$ more than 120 kilometers; $J = \frac{1}{40} D$ .	

The persistence and perfection of the ring-form in both small and large craters would, at first sight, lead to the conclusion that all were formed in a similar way. The table seems to the author to indicate that different processes have been at work. The ring-craters are not all models copied from one type, but the general form varies with the absolute diameter. The broader the crater the less the interior depth. These facts seem to the author to invalidate the volcanic theory of the formation of such ring-craters. Under such a theory the broadest craters should also be the deepest, whereas the contrary is the case.

3d: While the *relative* depth of the larger craters is less than that of the smaller, the larger craters always have the greatest *absolute* depths.

4th: The height of the outer wall, above the general surface of the Moon, is greater for the larger than for the smaller craters and seems to vary with the diameter in general. Certain interesting exceptions are noted by the author.

5th: The relation of the inner depth ( $J$ ) to the outer height ( $A$ ) is next discussed. The smaller the crater the larger is  $\frac{J}{A}$ ; that is, the nearer the form approaches to that of a simple cavity without bounding walls. As the diameter increases  $\frac{J}{A}$  becomes smaller.

When  $D$  becomes about 90 kilometers or larger  $\frac{J}{A}$  becomes constant and equal to about  $2\frac{1}{2}$ . That is, for craters above 50 miles in diameter the depth is pretty regularly about  $2\frac{1}{2}$  times the height of the outer wall above the surrounding country.

6th: In a general way, the absolute depth of a crater ( $J - A$ ) is greater for the larger craters, but there are many exceptions.

7th: The height of the interior peaks ( $h$ ) is never so great as the depth of the crater ( $J$ ).  $\frac{J}{h}$  is always greater than unity.

8th: The larger the diameter of a crater the greater is the volume of its interior cavity as compared to the volume of its wall. For the smallest craters the volume of wall is many times that of the interior cavity.

9th: To the preceding I add the interesting fact that the average angle of interior slope is  $34.5^\circ$ , and of outer slope  $6.9^\circ$ , taking all the 92 craters together.

The foregoing summary shows that considerable light is thrown

upon the laws of formation of the lunar craters by the systematic examination which Dr. EBERT has made of the comparatively small amount of data at his disposition. A careful study of a set of lunar photographs would add greatly to the materials available for such a discussion.

E. S. H.

#### SCIENTIFIC VISITORS TO THE LICK OBSERVATORY.

The great refractor of 25 inches aperture made by COOKE for the late Mr. NEWALL of Ferndene, Gateshead, England, has been presented to the University of Cambridge by his family, in accordance with Mr. NEWALL's wishes, and generous provisions have been made for installing the telescope at Cambridge. Mr. H. F. NEWALL, a son of the donor, has volunteered to give his services for a term of years as Astronomer.

Before beginning his work Mr. NEWALL desired to inspect the great observatories of the world, and he has not hesitated before the long journey to California, in order that he might study the equipment of the Lick Observatory, and particularly the mounting and performance of the great equatorial. The rainy season of California obligingly postponed its coming this year a month later than usual, and although our visitors were on a short allowance of water, they had excellent observing weather. The spectroscope for the NEWALL telescope will be provided by a grant from the BRUCE fund, and will contain some, at least, of the admirable features of the Lick Observatory instrument.

A letter lately received from the Earl of ROSSE announces that he will visit Mount Hamilton during the present winter. This is the second visit of Lord ROSSE to the United States.

The Prussian Government proposes to equip the Potsdam Observatory with a giant-telescope in order that the admirable spectroscopic observations of Professor VOGEL may be extended to the stars of the 4th and 5th magnitude. Before ordering such a telescope Professor AUWERS, Secretary of the Royal Academy of Sciences of Berlin, will be sent by the Government to inspect various astronomical establishments. Among other places, he will visit the Lick Observatory some time during the coming summer. To all our distinguished visitors the astronomers of Mt. Hamilton extend a hearty welcome.

E. S. H.